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(54) Intercooler for an engine

(57) An intercooler for an engine comprises a first tank part (112) with an inlet area (130) and an outlet area (134); a second tank part (14); and a heat exchanger part (16) comprising a number of ducts that communicate at one end with said first tank part (112) and at the other end with said second tank part (14), said inlet and outlet areas (130, 134) each being associated with a respective number of ducts (22_1, 22_4) of said heat exchanger part (16). The intercooler further comprises bypass and flow control means in said first tank part (112) operable to direct a flow of air from said inlet area (130) to said outlet area (134) without flowing through said heat exchanger part (16) and for controlling the flow rate through said heat exchanger part (16).

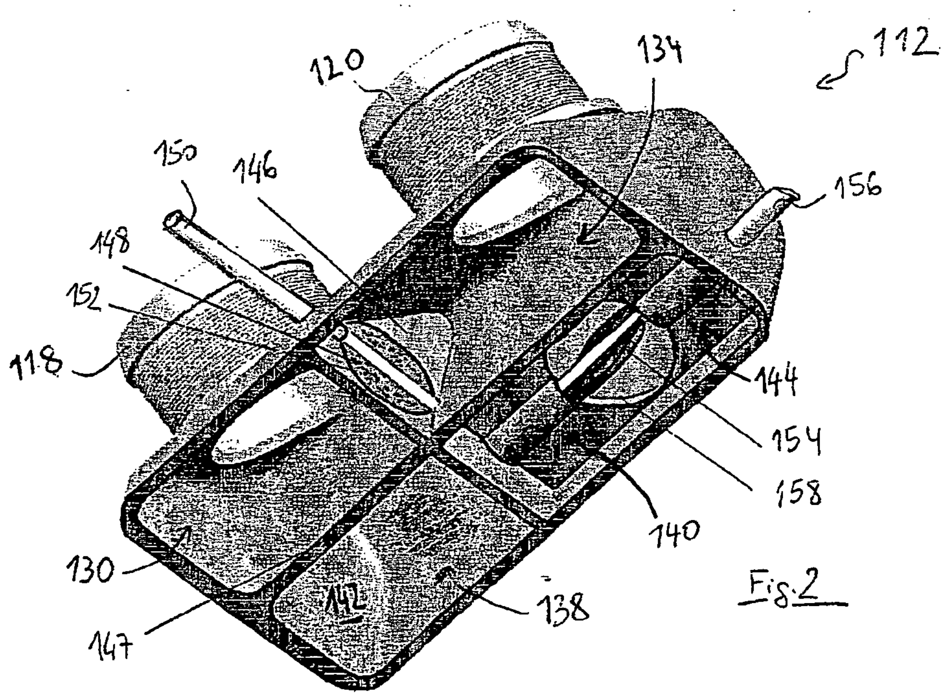

Fig.2

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Description

FIELD OF THE INVENTION

[0001] The present invention generally relates to an intercooler for an engine.

BACKGROUND OF THE INVENTION

[0002] Intercoolers are conventionally used in turbocharged or supercharged engines to cool down the charge air before it enters the combustion chambers. An intercooler is thus generally inserted between the outlet of the turbocharger, or supercharger respectively, and the intake manifold.

[0003] Depending on the engine operating conditions, it may be desirable to bypass the intercooler, to take advantage of the hot temperature of the compressed intake air exiting the turbocharger.

[0004] It is known to bypass an intercooler by providing a bypass duct that is connected upstream and downstream of the intercooler. A bypass valve arranged in the bypass duct allows to control the flow rate of intake air that bypasses the intercooler. Such an arrangement requiring a specific bypass duct and an associated bypass valve is complicated and requires an expensive design for the bypass duct. In engines equipped with an EGR (Exhaust Gas Recirculation) system, it is also known to provide a so-called MRVR (manifold vacuum regulating valve) at the exit of the intercooler, to control the pressure downstream of the intercooler and thereby influence the rate of EGR in the engine. The MVRV is also used during engine shut-off to hinder the flow of air so as to strangle the engine. To meet all these functions, the bypass duct needs to merge in the intake duct downstream of the MVRV. This complicates the packaging of the bypass duct.

[0005] US 5,632,256 discloses an intercooler having a first tank part with an inlet and an outlet chamber, a second tank part, and a heat exchanger part extending between the first and second tank parts. The heat exchanger part comprises a plurality tubes for cooling the charge air flowing therethrough, each of the inlet and outlet chambers being associated with a respective number of tubes. The second tank part is designed in such a way as to direct air coming from the tubes associated with the inlet chamber into the tubes associated with the outlet chamber, so that the charge air follows a U-shaped flow path within the intercooler. The first tank part is provided with an adjustable flap, which in its closed position separates the inlet chamber from the outlet chamber. When this flap is moved into its open position, charge air entering the inlet chamber can directly flow to the outlet chamber, so as to bypass the heat exchanger part of the intercooler. In order to be capable of completely closing the flow of charge air through the heat exchanger, the second tank part is also provided with such an adjustable flap.

[0006] Using the intercooler of US 5,632,256 allows avoid the complex, space consuming conventional arrangement consisting of a separate bypass duct and associated switching means. However, it requires a substantial modification of the intercooler structure as well as flap actuating means about the first and second tank parts.

OBJECT OF THE INVENTION

[0007] The object of the present invention is to provide an alternative, more compact intercooler for an engine. This object is achieved by an intercooler as claimed in claim 1.

SUMMARY OF THE INVENTION

[0008] An intercooler according to the present invention comprises a first tank part with an inlet area and an outlet area, and a second tank part. The intercooler further includes a heat exchanger part comprising a plurality of ducts that communicate at one end with the first tank part, and at the other end with the second tank part; the inlet and outlet areas of the first tank part each being associated with a respective number of ducts of the heat exchanger part.

[0009] According to an important aspect of the invention, the first tank part further includes bypass and flow control means operable to direct a flow of air from the inlet area to the outlet area without flowing through the heat exchanger part and for controlling the flow rate of air through the heat exchanger part.

[0010] Hence, the present intercooler has bypass and flow control means integrated in the first tank part, so that there is no need to provide a flap in the second tank part nor actuating means for actuating such a flap. This allows for a more compact arrangement of the intercooler in the engine compartment than that of the intercooler of US 5,632,256. The bypass and flow control means allow to operate the intercooler in a cooling mode, wherein the hot intake air - coming from the compressor outlet of the turbocharger- circulates through the heat exchanger part and is cooled. The bypass and flow control means also allow operation of the intercooler in a bypass mode, wherein hot intake air entering the inlet area is directed to the outlet area without flowing through the heat exchanger part, so that it is not cooled in the intercooler. Hence, hot intake air is admitted in the engine cylinders, which can be of interest for heating-up the engine more quickly. Furthermore, bypassing the intercooler results in a temperature increase of the exhaust gases, which is interesting for Diesel Particulate Filter regeneration, as the hot exhaust gas temperature is required to burn the particulates collected in the filter via post-injection. Depending on the design of the bypass and flow control means, it is also possible to only partially bypass the heat exchanger, so that a temperature controlled air is delivered by the outlet area.

[0011] According to a first design type, the intercooler is configured so that the intake air makes two passages through the heat exchanger part, thereby following a U-shaped flow path. The second tank part is configured to divert the air flow coming from the ducts associated with the inlet area to the ducts associated with the outlet area.

[0012] In a first embodiment of this first design type, a partition wall divides the inlet area into an upstream chamber with an inlet duct and a downstream chamber in communication with the associated ducts of the heat exchanger part. The bypass and flow control means comprise a bypass valve arranged so that, in its open position, the upstream chamber communicates with the outlet area; and in its closed position all air flows through the heat exchanger part. The bypass and flow control means further include a flow control valve arranged in the partition wall.

[0013] In a second embodiment, a partition wall divides the outlet area in a downstream chamber with an outlet duct and an upstream chamber in communication with the associated ducts of the heat exchanger part. The bypass and flow control means comprise a bypass valve arranged so that, in its open position, the upstream chamber communicates with the inlet area. The bypass and flow control means further include a flow control valve arranged in the partition wall.

[0014] Both these embodiments thus allow a compact arrangement of the intercooler in the engine compartment, since the valves are integrated in a single tank part, and no actuating means are required in the vicinity of the second tank part. In addition, this allows for a very basic design of the second tank part, which only serves as flow diverting area so that the intake air follows a U-shaped flow path in the heat exchanger part.

[0015] According to a second design type, the intercooler is designed so that intake air makes four passages through the heat exchanger part. Therefore, the first tank part preferably further includes a flow diverting area associated with a first number of ducts and a second number of ducts of the heat exchanger part, so that air arriving from the first number of ducts is diverted to the second number of ducts. The second tank part comprises a first flow diverting area for directing an air flow arriving from the ducts associated with the inlet area into the first number of ducts; and a second flow diverting area for directing an air flow arriving from the second number of ducts to the ducts associated with the outlet area.

[0016] According to a first embodiment of the second design type, the bypass and flow control means include a bypass valve operable to allow an air flow to pass from the inlet area to the outlet area without flowing through the heat exchanger part. The bypass and flow control means further comprise a flow control valve arranged in the flow diverting area in the first tank part and operable to control the rate flow of air through the heat exchanger part. A first partition wall divides the flow diverting area in the first tank part into an upstream chamber in communication with the first number of ducts and a downstream chamber in communication with the second number of ducts. The flow control valve is arranged in this first partition wall.

[0017] This is an even more compact design of the first tank part, since the flow control valve is not anymore arranged in the inlet or outlet area with the bypass valve, but in the separate flow diverting area of the first tank part. Furthermore, this embodiment allows to strangle the engine during shut-off, by closing both the bypass valve and flow control valve.

[0018] In a second embodiment, the bypass valve is arranged in a second partition wall separating the inlet area from the outlet area, this second partition wall being aligned with the first partition wall. Hence, the bypass and flow control valves are arranged in a same wall portion, which facilitates the actuation of the valves and the design of the actuation means. In this connection, the bypass valve and the flow control valve preferably are flap valves which are mounted on a same actuating shaft, both flap valves being arranged at 90° with respect to each other on the shaft. This thus allows controlling the bypass and flow control valves by means of a single actuating shaft, therefore requiring only one actuator that can be installed outside the intercooler. It will be understood that due to the offset between the flaps, when the bypass valve is closed the flow control valve is open, and vice versa.

[0019] In a third embodiment, a partition wall separates the flow diverting area from the inlet and outlet areas. The bypass and flow control means advantageously comprise a moveable wall part of the partition wall. In a default, closed position, the moveable wall part is aligned with the partition wall and the intercooler operates in the cooling mode. The moveable wall part can be moved into an open position in the flow diverting area, to allow intake air to flow from the inlet area to the outlet area via the flow diverting area, while simultaneously hindering the flow of air from the first number of ducts to the second number of ducts. In this embodiment only one flap is required to open the bypass and block the flow of air through the heat exchanger part.

[0020] In the second and third embodiments, the counterpart of the simple bypass and flow control means is that engine strangling is not possible. They can thus be used in case strangling by the intercooler is not required.

[0021] Actuation of the bypass valve, flow control valve, or the moveable wall part is preferably done my means of actuators mounted to the external walls of the first tank part. The actuators may be provided with position sensors to allow closed loop control.

[0022] The intercooler may be provided with temperature control means for actuating the bypass and flow control means. Such a temperature control means will thus control the different flaps in such a way that the air flow exiting the intercooler has a temperature corre-

sponding to a desired temperature.

[0023] In order to strangle the engine during shutt-off, the bypass and flow control valves should preferably be designed so as to tightly seal in their closed position.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] The present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

FIG.1: is a schematic exploded view of an intercooler according to the invention;

FIG.2: is a perspective view -from below- of a first embodiment of a first tank part, with the bypass valve closed and the flow control valve open;

FIG.3: is a perspective view showing the inner structure of the first tank part of Fig.2 assembled to the heat exchanger part, with the bypass valve open and the flow control valve closed;

FIG.4: is a perspective view -from below- of a second embodiment of a first tank part, with the bypass valve closed and the flow control valve open;

FIG.5: is a perspective view showing the inner structure of the first tank part of Fig.4 assembled to the heat exchanger part, with the bypass valve open and the flow control valve closed;

FIG.6: is a perspective view -from below- of a third embodiment of a first tank part, configured for operation in the cooling mode;

FIG.7: is a perspective view showing the inner structure of the first tank part of Fig.6 assembled to the heat exchanger part, configured for operation in the bypass mode.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0025] Three embodiments according to a preferred design of the present inter-cooler will now be described in more detail. As shown in Fig.1, the intercooler 10 comprises a first tank part 12, a second tank part 14 and a heat exchanger part 16. The first tank part 12 has an inlet duct 18 for receiving hot, compressed intake air from a turbocharger compressor outlet and an outlet duct 20 for delivering cooled intake air to an engine intake manifold.

[0026] It is to be noted that in the three embodiments described herebelow, intake air to be cooled in the intercooler 10 makes four passages in the heat exchanger part 16. Therefore, the heat exchanger part 16 is shown in the Figures as having a housing 17 divided into four sections $22_1...22_4$. However, it is to be noted that, although not shown, each of these sections $22_1...22_4$ comprises a plurality of longitudinally arranged tubes that allow transferring intake air between the first and second tank parts 12 and 14. In addition, the heat exchanger part 16 is designed in such a way that air can flow therethrough e.g. in the direction of arrow 24, and thus between the ducts, so as to cool the intake air circulating through the ducts in each section 22_i.

[0027] The second tank part 14 is designed so as to comprise two flow diverting areas 26 and 28. From Fig. 1 it can clearly be seen that, due to the configuration of the second tank part 14, an air flow arriving in the second tank part 14 from the ducts of the first section 22_1 will be diverted into the ducts of the second section 22_2. Moreover, an air flow arriving from the ducts of the third section 22_3 will be diverted into the ducts of the fourth section 22_4. This is simply done by providing in the second tank part 14 a fixed partition wall 29 dividing it into the two areas 26 and 28, the area 26 being in communication with the ducts of the first 22_1 and second 22_2 sections and the area 28 being in communication with the ducts of the third 22_3 and fourth 22_4 sections.

[0028] It will be appreciated that the present intercooler 10 includes a first tank part 12 that is provided with bypass and flow control means operable to bypass the heat exchanger part and for controlling the flow rate of air through the heat exchanger part. As will be explained, this allows operating the intercooler in a cooling mode, wherein the intake air entering the inlet area flows through the heat exchanger part 16 to be cooled; and in a bypass mode, wherein the intake air is directed from the inlet area to the outlet area without circulating through the heat exchanger part 16.

[0029] The three different embodiments of the first tank part 12 will now be described in detail with respect to Figures 2 to 7.

[0030] Figures 2 and 3 show a first embodiment of a first tank part 112. It comprises an inlet area 130 with an inlet duct 118 and an outlet area 134 with an outlet duct 120. It will be understood that, when this first tank part 112 is mounted on the heat exchanger part 16 in the way shown in Fig.1, the inlet area 130 is in communication with the ducts of the first section 22_1 and the outlet area 134 is in communication with the ducts of the fourth section 22_4. The first tank part 112 further includes a flow diverting area 138 that is associated with the ducts of the second 22_2 and third 22_3 sections of the heat exchanger part 16.

[0031] The flow diverting area 138 is divided by a horizontal, first partition wall 140 into an upstream chamber 142 in communication with the ducts of the second section 22_2 and a downstream chamber 144 in communication with the ducts of the third section 22_3. The inlet area 130 and outlet area 134 are separated by a second partition wall 146. A central longitudinal wall 147 separates the inlet and outlet areas 130, 134 from the flow diverting area 138.

[0032] It will be appreciated that the bypass and flow control means provided in the first tank part 112 comprise a bypass valve arranged in the second partition wall 146 and a flow-control valve arranged in the first partition wall 140. The bypass valve is preferably in the form of a circular flap valve 148 mounted on a shaft 150 and operable to either close or open a circular opening 152 in the second partition wall 146, to allow intake air to directly flow from the inlet area 130 to the outlet area 134.

[0033] The flow control valve is preferably in the form of a circular flap valve 154 mounted on a shaft 156 and operable to either close or open a circular opening 158 in the first partition wall 140, so as to control the flow rate of intake air through the heat exchanger part 16.

[0034] In Fig.2, the bypass valve is closed and the flow control valve is open, so that intake air entering the inlet area 130 flows through the ducts of the first, second, third and fourth section $22_1...22_4$ to the outlet area 134. By flowing through the ducts of the different sections, hot intake air is cooled by the ambient air traversing the heat exchanger part 16 in the direction of arrow 24 (Fig.1), so that cooled intake air exists the intercooler 10.

[0035] In Fig.3, the bypass valve is open and the flow control valve is closed, so that all intake air directly flows from the inlet area 130 to the outlet area 134 without being cooled in the heat exchanger part 16.

[0036] It is to be noted that the flow control valve has a function equivalent to the so-called MVRV (manifold vacuum regulating valve), and thus allows to block the flow through the intercooler 10 during engine shut-off. Hence, such an implementation does not require a special MVRV housing at the exit of the intercooler, and packaging is thus significantly smaller. In addition, the integration of both valves in the first tank part is favorable in terms of durability since the valves are chassis mounted.

[0037] Actuation of the flaps 154 and 148 is advantageously carried out by means of actuators (not shown) coupled to the shafts 150 and 156 and mounted to outside walls of the first tank part 112. The actuators may be provided with position sensors to allow closed loop control.

[0038] To efficiently strangle the engine during shut-off, the bypass and flow control valves should preferably be designed so as to provide a tight seal in their closed position.

[0039] A second embodiment of the first tank part 212 is shown in Figures 4 and 5. The first tank part 212 comprises an inlet area 230 with an inlet duct 218 and an outlet area 234 with an outlet duct 220. When this first tank part 212 is mounted on the heat exchanger part 16 in the way shown in Fig.1, the inlet area 230 is in communication with the ducts of the first section 22_1 and the outlet area 234 is in communication with the ducts of the fourth section 22_4. The first tank part 212 further includes a flow diverting area 238 that is associated with the ducts of the second 22_2 and third 22_3 sections of the heat exchanger part 16.

[0040] The flow diverting area 238 is divided by a first partition wall 240 into an upstream chamber 242 in communication with the ducts of the second section 22_2 and a downstream chamber 244 in communication with the ducts of the third section 22_3. The inlet area 230 and outlet area 234 are separated by a second partition wall 246. A central longitudinal wall 247 separates the inlet and outlet areas 230, 234 from the flow diverting area 238.

[0041] The bypass valve is preferably in the form of a circular flap valve 248 mounted on a shaft 250' and operable to either close or open a circular opening 252 in the second partition wall 246, to allow intake air to directly flow from the inlet area 230 to the outlet area 234.

[0042] The flow control valve is preferably in the form of a circular flap valve 254 operable to either close or open a circular opening 258 in the first partition wall 240, so as to control the flow rate of intake air through the heat exchanger part 16.

[0043] As can be seen, the two partition walls 240 and 246 are aligned, which allows mounting the flap 254 of the flow control valve on the shaft 250' on which the flap 248 of the bypass valve is mounted. The two flaps 248 and 254 are arranged at 90° with regard to each other, so that when the bypass flap 252 is in the closed position, the flow-control flap 254 is open, and vice versa.

[0044] This implementation thus allows controlling both flaps 252 and 254 with a single actuating shaft, and thus requires only one actuator.

[0045] Regarding the first and second embodiments of Figs.2 to 5, it will be noted that if a precise actuation is required, the valve openings may each be provided with a short duct and the respective flaps mounted therein. Such a short duct is designed in such a way that the flap valve mounted therein follows a spherical bore, thereby allowing a progressive control.

[0046] Turning now to Figures 6 and 7, a third embodiment of a first tank part 312 to be used in the present intercooler is shown. The first tank part 312 comprises an inlet area 330 with an inlet duct 318 and an outlet area 334 with an outlet duct 320. When this first tank part 312 is mounted on the heat exchanger part 16 in the way shown in Fig.1, the inlet area 330 is in communication with the ducts of the first section 22_1 and the outlet area 334 is in communication with the ducts of the fourth section 22_4. The first tank part 312 further includes a flow diverting area 338 that is associated with the ducts of the second 22_2 and third 22_3 sections of the heat exchanger part 16.

[0047] As can be seen, the inlet area 330 and outlet area 334 are separated by a first partition wall 340. The first tank part 312 further includes a longitudinal partition wall 342 that separates the inlet and outlet areas 330, 334 from the flow diverting area 338.

[0048] It will be appreciated that the bypass and flow control means comprise a moveable wall portion 344 of

the longitudinal partition wall 342, that is operable as a flap by means of a shaft 346.

[0049] When the moveable wall portion 344 is in the default, closed position of Fig.6, i.e. aligned with the wall 342, the intercooler 10 operates in the cooling mode: intake air entering the inlet area 330 makes four passages through the heat exchanger part 16 before reaching the outlet area 334.

[0050] As will be understood from Fig.7, the moveable wall portion 344 can be rotated in the flow diverting area 338 into an open position so as to hinder the communication between the ducts of the second 22_2 and third 22_3 sections and the flow diverting area 338. Hence, in the configuration of Fig.7, the flow of air though the heat exchanger part 16 is prevented by the moveable wall portion 344. Bringing the moveable wall portion 344 in this open position also enables communication between the inlet area 330, outlet area 334 and the flow diverting area 338, so that an air flow entering the inlet area 330 flows to the outlet area 334 via the flow diverting area 338, without circulating through the heat exchanger part 16.

[0051] Actuation of the moveable wall portion 344 is preferably achieved by means of an actuator (not shown) coupled to the shaft 346 and mounted on the external walls of the first tank part 312. Alternatively, the moveable wall portion 344 may be cam driven, compromising on a slow opening but allowing a rapid spring controlled return to default position (aligned with the partition wall 342 for cooling).

[0052] It remains to be noted that in the presented embodiments, it is possible to control the bypass and flow control means in such a way as to completely, partially, or not at all cool the hot compressed air entering the inlet area.

[0053] Therefore, the intercooler may include a temperature control means that is capable of operating the bypass and flow control means to deliver an air flow of desired temperature. The temperature control means may operate in closed loop based on a temperature sensor or a flap/actuator position sensor.

[0054] The present intercooler, in its various embodiments, also proves advantageous in that:

- it is less subject to leakage than the conventional structure using a separate bypass duct and an MVRV,
- it has an improved vibration resistance since the intercooler is generally chassis mounted;
- the integration of both bypass and flow control valves in the first tank part simplifies packaging and leads to a gain of space in the engine compartment;
- it is a cost efficient solution.

Claims

1. An intercooler for an engine comprising:

   a first tank part (12, 112, 212, 312) with an inlet area (130, 230, 330) and an outlet area (134, 234, 334);

   a second tank part (14);

   a heat exchanger part (16) comprising a number of ducts (22_1...22_4) that communicate at one end with said first tank part (12, 112, 212, 312) and at the other end with said second tank part (14), said inlet and outlet areas (130, 230, 330; 134, 234, 334) each being associated with a respective number of ducts (22_1; 22_4) of said heat exchanger part (16);

   characterized by
   bypass and flow control means in said first tank part (12, 112, 212, 312) operable to direct a flow of air from said inlet area (130, 230, 330) to said outlet area (134, 234, 334) without flowing through said heat exchanger part (16) and for controlling the flow rate through said heat exchanger part (16).

2. The intercooler according to claim 1, **characterised in that**
   a partition wall divides said inlet area into an upstream chamber in communication with an inlet duct and a downstream chamber in communication with said associated ducts of said heat exchanger part;
   said bypass and flow control means include a bypass valve arranged so that, in its open position, said upstream chamber communicates with said outlet area; and
   said bypass and flow control means include a flow control valve arranged in said partition wall.

3. The intercooler according to claim 1, **characterised in that**
   a partition wall divides said outlet area into a downstream chamber in communication with an outlet duct and an upstream chamber in communication with said associated ducts of said heat exchanger;
   said bypass and flow control means include a bypass valve arranged so that, in its open position, said upstream chamber communicates with said inlet area; and
   said bypass and flow control means include a flow control valve arranged in said partition wall.

4. The intercooler according to claim 1, **characterised in that**
   said first tank part (112, 212, 312) further includes a flow diverting area (138, 238, 338) associated with a first number of ducts (22_2) and a second number

of ducts (22_3) of said heat exchanger part (16), so that air arriving from said first number of ducts (22_2) is diverted to said second number of ducts (22_3); and

said second tank part (14) comprises a first flow diverting area (26) for directing an air flow arriving from the ducts (22_1) associated with said inlet area (130, 230, 330) into said first number of ducts (22_2), and a second flow diverting area (28) for directing an air flow arriving from said second number of ducts (22_3) to said ducts (22_4) associated with said outlet area (134, 234, 334).

5. The intercooler according to claim 4, **characterised in that**

said bypass and flow control means include a bypass valve operable to allow an air flow to flow from said inlet area (130, 230) to said outlet area (134, 234) without passing through said heat exchanger part (16); and

said bypass and flow control means include a flow control valve arranged in said flow diverting area (138, 238) in said first tank part (112, 212) operable to control the flow rate through said heat exchanger part (16).

6. The intercooler according to claim 4 and 5, **characterised in that**

a first partition wall (140, 240) divides said flow diverting area (138, 238) in said first tank part (112, 212) into an upstream chamber (142, 242) in communication with said first number of ducts (22_2) and a downstream chamber (144, 244) in communication with said second number of ducts (22_3); and

said flow control valve is arranged in said partition wall (140, 240).

7. The intercooler according to claim 6, **characterised in that**

a second partition wall (246) separates said inlet area (230) from said outlet area (234);

said bypass valve is arranged in said second partition wall (246); and

said second partition wall (246) is aligned with said first partition wall (240).

8. The intercooler according to claim 7, **characterised in that**

said bypass valve and said flow control valve are flap valves (248, 254) which are mounted on a same actuating shaft (250'), both flap valves (248, 254) being arranged at right angle with respect to each other.

9. The intercooler according to any one of claims 4 to 8, **characterised in that**

said bypass valve and flow control valve are each a flap valve associated with a valve opening; and

a short duct is mounted in each valve opening and the respective flap valve is mounted in this short duct, which is provided with a spherical bore.

10. The intercooler according to any one of claims 4 to 9, **characterised in that** said bypass valve and flow control valve are designed in such a way as to provide a tight sealing in their closed position.

11. The intercooler according to claim 4, **characterised in that** a partition wall (342) separates said flow diverting area (338) from said inlet and outlet areas (330, 334); and

said bypass and flow control means includes a moveable wall part (344) of said partition wall (342), that can be moved in said flow diverting area (338) to allow air to flow from said inlet area (330) to said outlet area (334) via said flow diverting area (338), and simultaneously hindering air flow through said first and second number of ducts (22_2; 22_3).

12. The intercooler according to any one of the preceding claims, **characterised by** temperature control means for actuating said bypass and flow control means to provide a desired temperature of the air flow exiting said outlet chamber (134, 234, 334).

13. The intercooler according to any one of claims 4 to 12, **characterised in that** said an inlet duct (118,218, 318) opens into said inlet area (130, 230, 330) and an outlet duct (120, 220, 320) opens into said outlet area (134, 234, 334).

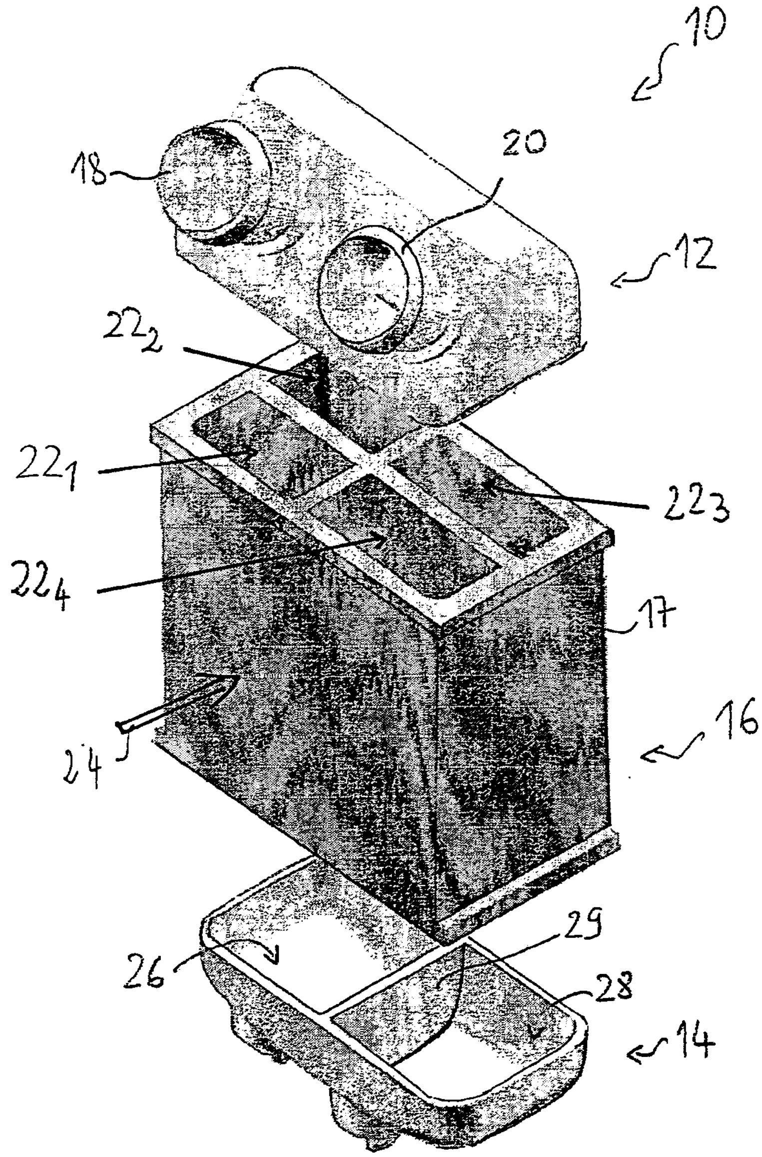

Fig. 1

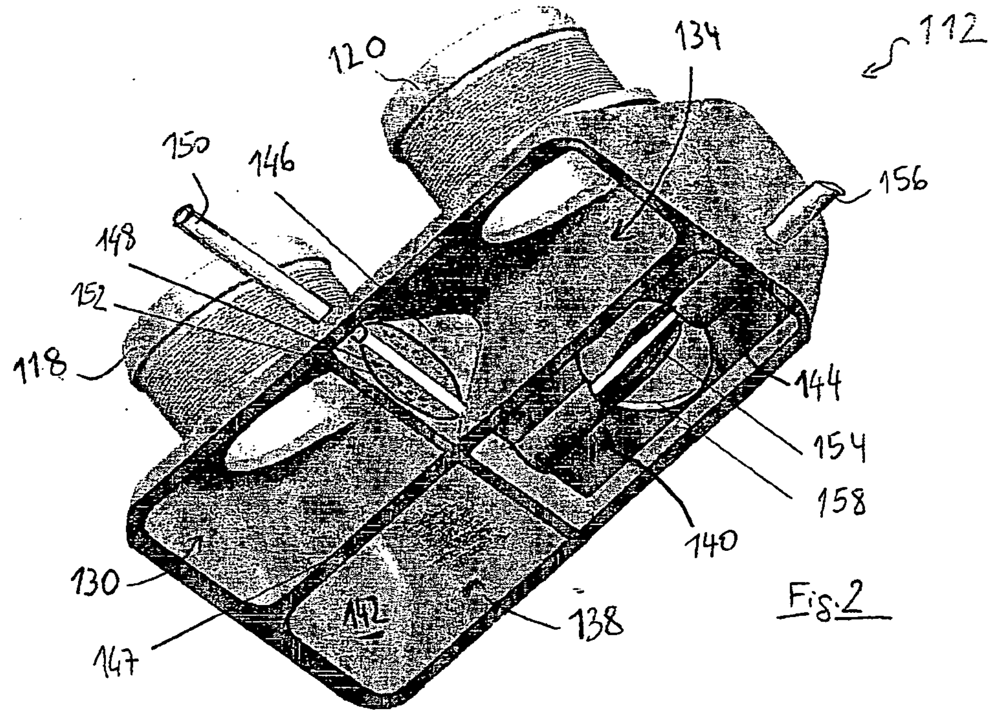
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Fig. 2

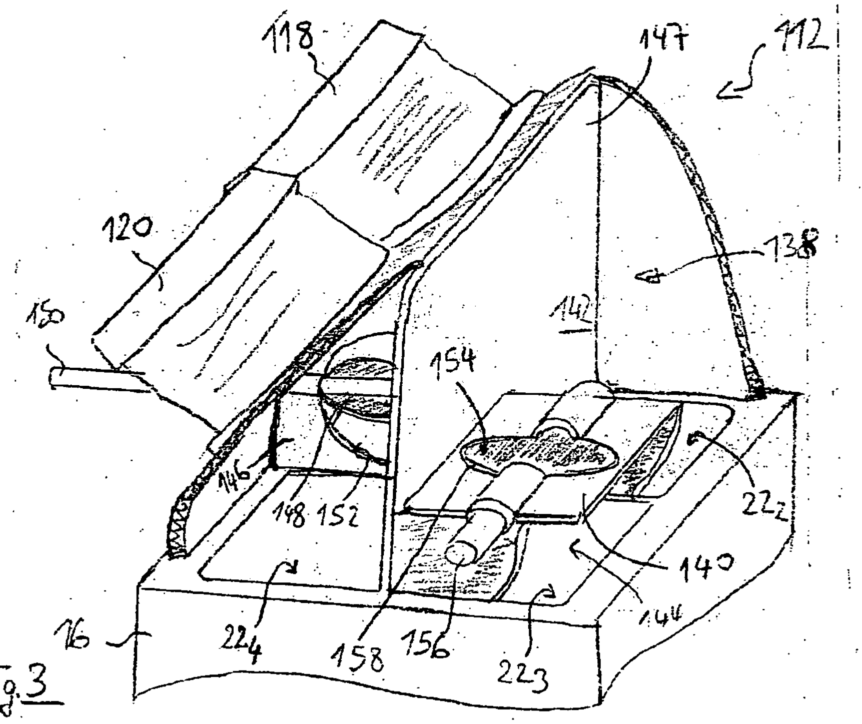
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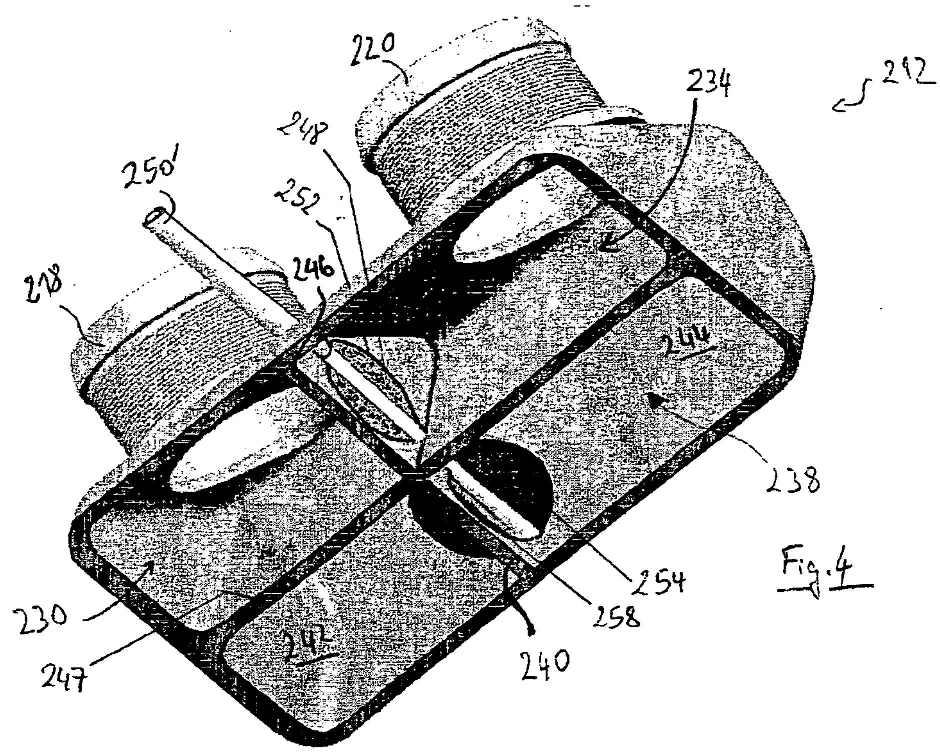
Fig. 3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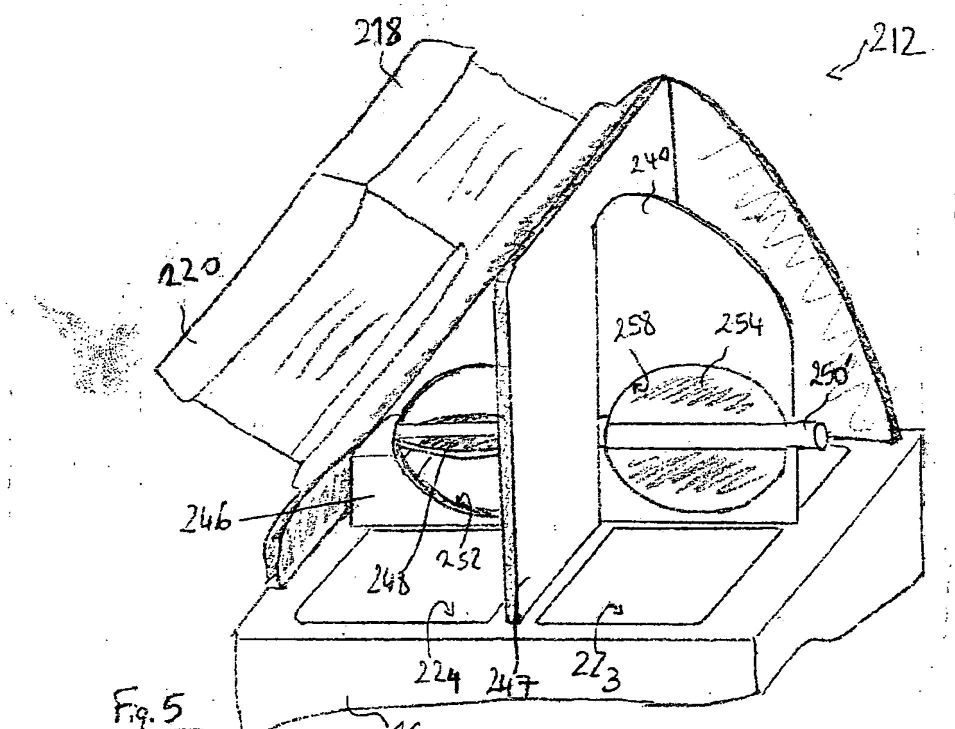
242
240

Fig. 4


218
212
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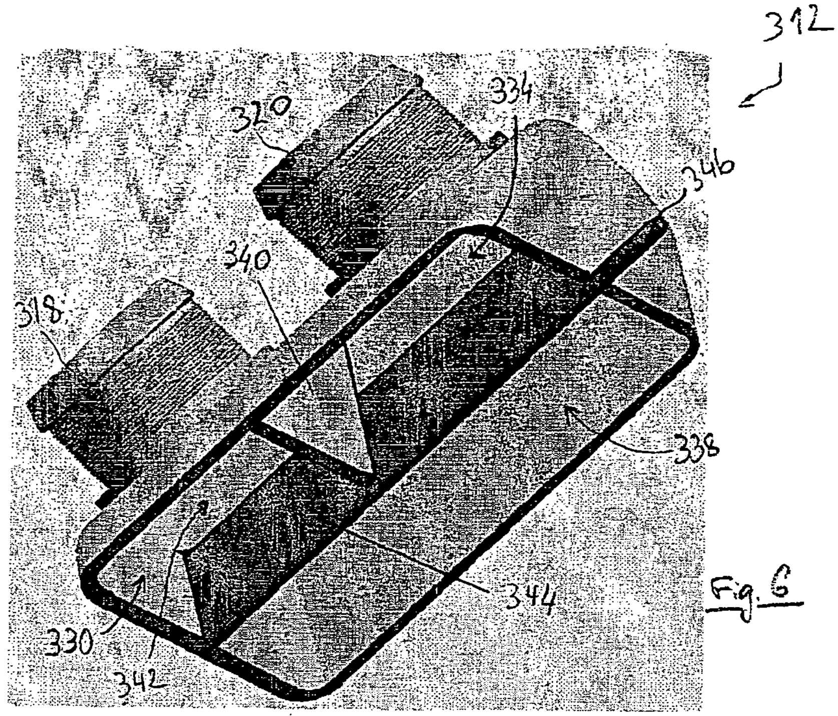
258
254
250'
246
248
252
224
247
223
16

Fig. 5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340
318
338
344
330
342

Fig. 6

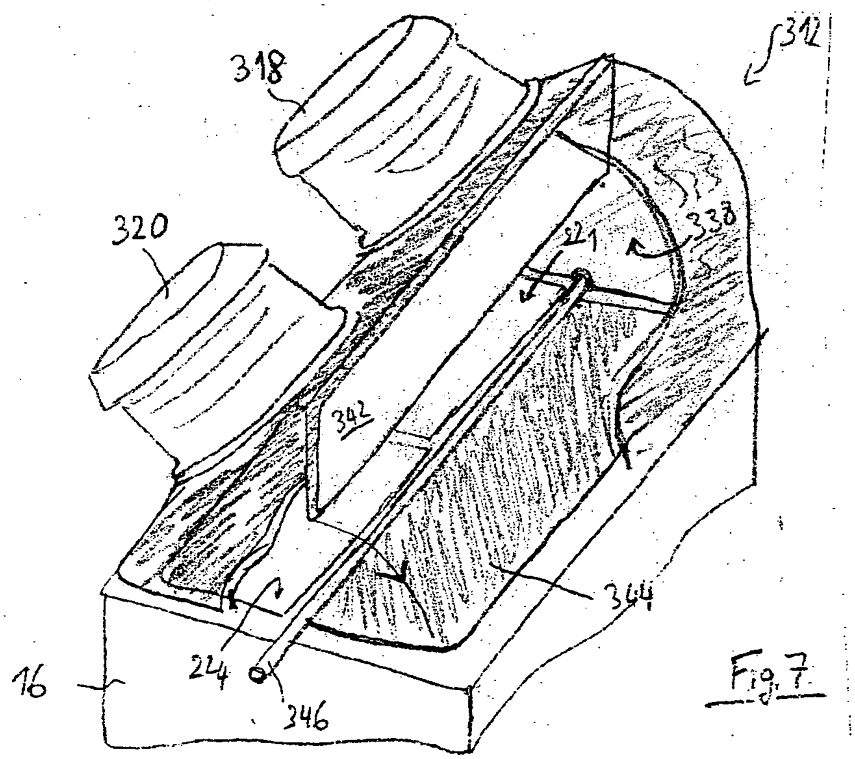
318
312
320
338
342
344
224
346
16

Fig. 7